

## Variation in the Global Direct Radiative Climate Forcing by Well-Mixed Greenhouse Gases over the Past 25 Years

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The perturbation to radiative climate forcing, which has the largest magnitude and the least scientific uncertainty, is the forcing related to changes in long-lived and well-mixed greenhouse gases, in particular carbon dioxide ( $\text{CO}_2$ ), methane ( $\text{CH}_4$ ), nitrous oxide ( $\text{N}_2\text{O}$ ) and the halocarbons (mainly CFCs). All of these gases have been monitored around the world since the 1970s mainly by NOAA's Climate Monitoring and Diagnostics Laboratory (CMDL) in Boulder, Colorado, and its forerunner, the Geophysical Monitoring for Climatic Change (GMCC) program. CMDL operates four fully instrumented baseline climate observatories at Pt. Barrow, Alaska; Mauna Loa, Hawaii; American Samoa; and South Pole Station, Antarctica, where the concentrations of the greenhouse gases are measured continuously as well as by discrete air samples. In addition, discrete air samples are collected through several global networks, including a cooperative program that provides samples from over 50 global sites. All discrete air samples are analyzed for gas concentrations and carbon and oxygen isotopic ratios in Boulder. These data will be presented and analyzed in terms of their changes and the changes in radiative forcing during the 25-year period encompassing 1979 through 2003. The most notable change in the past several years is an increase in the fraction of the forcing related to carbon dioxide from about 59% to 62%. This is mainly due to the fact that the radiative forcing by CFCs and  $\text{CH}_4$  have declined or grown only slowly in recent years.

Annual updates in radiative climate forcing by long-lived greenhouse gases have become a regular product of CMDL's research. We introduce a parameter, Annual Greenhouse Gas Index (AGGI) (Figure 1), which is the annual change in radiative forcing (milliwatts per square meter) due to increasing major greenhouse gases.

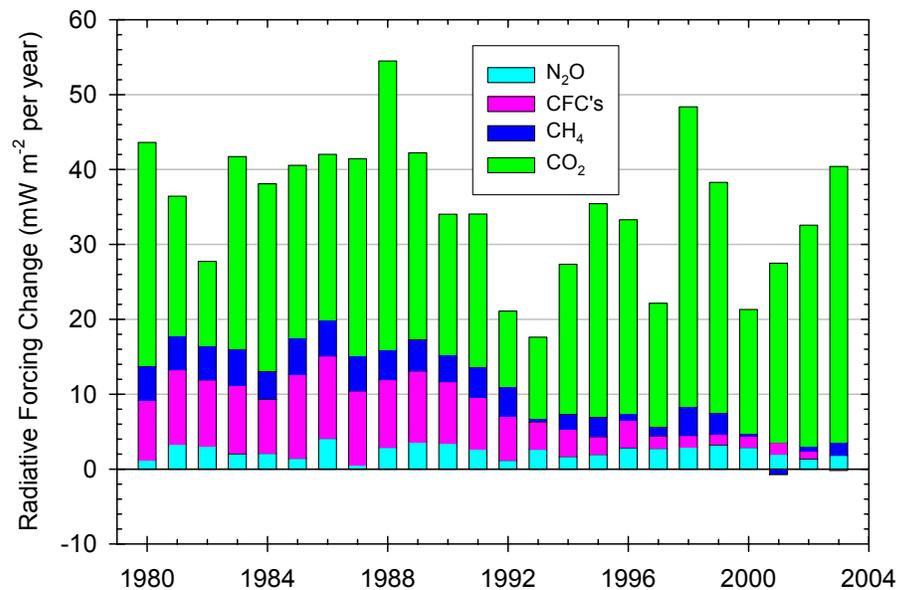


Figure 1. The Annual Greenhouse Gas Index, which is the annual change in radiative climate forcing caused by global changes in the four major greenhouse gases, carbon dioxide, methane, nitrous oxide and the chlorofluorocarbons (mainly CFC-11 and CFC-12) for the past 24 years from CMDL monitoring networks.